



U.S. Department
of Transportation
**Federal Aviation
Administration**

Advisory Circular

Subject: FLAP INTERCONNECTIONS IN
PART 23 AIRPLANES

Date: 11/13/92
Initiated by: ACE-100

AC No: 23.701-1
Change:

1. PURPOSE. This advisory circular (AC) provides information and guidance concerning an acceptable means, but not the only means, of showing compliance with the requirements of § 23.701 (amendment 23-42) of the Federal Aviation Regulations (FAR) applicable to flap interconnections. Accordingly, this material is neither mandatory nor regulatory in nature and does not constitute a regulation.

2. RELATED REGULATIONS. These acceptable means of compliance refer to certain provisions of part 23 of the FAR. They may be used in showing compliance with the corresponding provisions of the former Civil Air Regulations (CAR) in the case of airplanes where the CAR regulations are applicable. For convenience, the part 3 section reference is shown in parenthesis following the part 23 section reference:

§ 23.301 (3.171)	Loads
§ 23.303 (3.172)	Factor of safety
§ 23.345 (3.190)	High lift devices
§ 23.395 (3.231)	Control system loads
§ 23.457 (3.223)	Wing flaps
§ 23.572	Wing, empennage, and associated structures
§ 23.671 (3.335)	Control Systems: General
§ 23.697 (3.338)	Wing flap controls
§ 23.699 (3.338)	Wing flap position indicator
§ 23.1309	Equipment, systems, and installations

3. APPLICABILITY. This AC addresses the requirements in § 23.701 for flap interconnection. Novel and unusual design features such as an interconnection of the leading and trailing edge flap systems or an interconnection of flaps and ailerons would require special conditions. The applicable regulations in part 23 do not contain adequate or appropriate airworthiness standards for these types of control systems.

4. BACKGROUND.

a. Mechanical Interconnection. Section 23.701 requires that the motion of the flaps on opposite sides of the plane of symmetry must be synchronized by a mechanical interconnection unless the airplane has safe flight characteristics with the flaps retracted on one side

and extended on the other. When amendment 23-42 was incorporated, § 23.701 was restructured and the words "mechanical interconnection" were inadvertently changed to the words "mechanical connections." This inadvertent change has caused some misinterpretation. These terms mean the same thing, that is, a direct positive mechanical interconnection between separate flap surfaces in a flap actuating system.

b. Equivalent level of safety findings. Several findings have been accepted for the mechanical interconnections requirement. These equivalent level of safety findings are discussed in paragraph 6 of this AC.

5. DISCUSSION OF REQUIREMENTS.

a. Synchronized by a mechanical interconnection. These words have appeared in parts 23 and 25 of the FAR and even in Civil Air Regulations (CAR) 03 and 04b since they were first issued. The synchronization requirement for the motion of the flaps by a mechanical interconnection is applicable to airplanes not having safe flight characteristics under asymmetrical flap operations. For these cases, there would be a hazardous condition when the flaps are retracted on one side and extended on the other side.

b. Mechanical interconnection requirement of § 23.701(a)(1). This requirement is to ensure against hazardous asymmetrical operation of the flaps after any probable single or probable combination of failures of the flap actuating system. A probable combination of failures should be considered when the first failure would not be detected during normal operation of the system, including periodic checks, or when the first failure would inevitably lead to other failures. (Systems where a probable combination of failures may occur could include the electrical and hydraulic systems.) The airplane must also be shown to be capable of continued safe flight and landing without requiring exceptional pilot skill or strength following these failures. To demonstrate that the airplane is safe under these conditions, tests should be conducted with the flaps being retracted on one side and extended on the other during takeoffs, approaches, and landing. If there is a probable hazardous condition, a separate positive connection that is not part of the flap actuation system is required.

c. Amendment 23-42. This amendment was not intended to change the requirement: "The main wing flaps and related movable surfaces as a system must be synchronized by mechanical connection." The main purpose of this amendment was to add the requirement: "Maintain synchronization so that the occurrence of an unsafe condition has been shown to be extremely improbable." This requirement addresses provisions for synchronization of the flaps by means other than by mechanical interconnection of the flap.

6. ACCEPTABLE MEANS OF COMPLIANCE. An acceptable means of compliance with the airworthiness requirements for the flap's mechanical interconnections of § 23.701(a)(1) are described below:

a. Reliability. Reliability of the mechanical interconnections is generally shown by load analysis and/or load tests, not by numerical probabilistic analysis. The mechanical interconnection should be designed for the loads resulting when interconnected flap surfaces on one side of the plane of symmetry are jammed and immovable while the surfaces on the other side are free to move and the full power of the surface actuating system is applied. It must also be designed to account for the asymmetrical loads resulting from flight with the engines on one side of the plane of symmetry inoperative and the remaining engines at takeoff power. The flight loads from § 23.345 acting on the surfaces must be considered in combination with the actuating system loads (including system inertia loads). Critical air load conditions should consider flap retraction and flap extension including go-around. These conditions are considered limit loads. If there are no hazardous conditions when the flaps are asymmetrical, the jam or maximum load conditions could be considered an ultimate load.

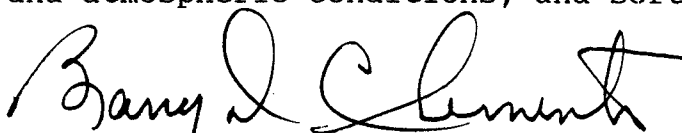
b. Friction Loads. It may be necessary to consider friction loads in the actuating system that may be reasonably expected to occur in service. Each design should be evaluated to determine its susceptibility to friction in the mechanism and any loads with such resistance.

c. Equivalent Means by Use of the Mechanical Actuation System. The mechanical actuating system for the flaps may be considered the mechanical interconnection if all elements are mechanically interconnected from the actuator source to the flaps. These mechanical elements may include structures, interconnection linkages, and drive system components. When the mechanical interconnection is through the actuating system and it is the only means to prevent an unsafe asymmetrical condition, the loads associated with the jam conditions are considered limit loads. A 1.5 factor of safety is required if a failure as a result of the jam condition would cause a hazardous flap asymmetrical operation. A mechanical actuating system having a 1.5 factor of safety may not need to be evaluated for probable failure conditions. Also, if the drive system is designed so that a hazardous flap asymmetrical operation would not occur after a jam condition, the 1.5 factor of safety should not be required.

d. Equivalent Means by Use of a Warning and Prevention System. A second equivalent means is the use of a warning and prevention system. This system monitors the symmetrical condition of the flaps and warns the pilot when an asymmetrical flap condition occurs, but the asymmetry is still kept within safe limits, and it prevents further movements of the flaps from exceeding the safe asymmetrical limits. The warning and prevention system should be independent for each functionally related set of surfaces, i.e., a set of flaps on each side of the plane of symmetry that is driven by a common actuator. Again, the airplane must be shown to have safe flight characteristics

without requiring exceptional piloting skill or strength at the extreme limits of the asymmetrical condition where the flaps are stopped. Tests should be conducted to simulate flap malfunctioning at the most severe case in the statically asymmetrical condition of the flaps during takeoffs, approaches, and landings. The warning and prevention system must provide a pilot with a selectable or automatic test mode that exercises the system to an appropriate depth so the pilot can determine proper operation of this system.

7. Electrical/Electronic Flap Interconnection System. When amendment 23-42 was adopted, § 23.701 was amended to include provisions for airplanes with a flap configuration other than a mechanical interconnection. This amendment added the requirement in § 23.701(a)(2), "Maintain synchronization so that the occurrence of an unsafe condition has been shown to be extremely improbable." This requirement is applicable for electrical/electronic flap interconnection systems such as airplanes that have additional flaps on canard and tandem wings. Guidelines for performing a design safety assessment by application of § 23.1309(b) as adopted by amendment 23-41 are given in AC 23.1309-1A, "Equipment, Systems, and Installations in Part 23 Airplanes," dated June 3, 1992. This AC also provides guidance regarding design safety assessments, environmental and atmospheric conditions, and software assessment.



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